UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
8604 La Jolla Shores Drive
La Jolla, California 92038

March 25, 2005

CRUISE REPORT

VESSEL: NOAA Ship *McArthur II*

CRUISE NUMBER: AR-04-05

CRUISE DATES: 27 June through 02 November 2004
Southwest Fisheries Science Center (SWFSC) Marine Mammal Cruise Number 1625

PROJECT: Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH)

SPONSOR: NOAA, NMFS, SWFSC Protected Resources Division (PRD)

CHIEF SCIENTIST: Dr. Jay Barlow, SWFSC (858) 546-7178

ITINERARY:

LEG 1: 27 JUN – Depart Seattle, WA	26 JUL – Arrive Kodiak, AK
LEG 2: 30 JUL – Depart Kodiak, AK	28 AUG – Arrive Dutch Harbor, AK
LEG 3: 01 SEP – Depart Dutch Harbor	29 SEP – Arrive Kodiak, AK
LEG 4: 03 OCT – Depart Kodiak, AK	02 NOV – Arrive Seattle, WA

CRUISE DESCRIPTION AND OBJECTIVES: The objective of the SPLASH 2004 cruise was to locate, collect data on and understand the distribution of humpback whales (*Megaptera novaeangliae*). This project was part of a larger international project (SPLASH) designed to estimate the abundance and determine the population structure for humpback whales throughout the North Pacific involving the governments of Canada and Mexico as well as multiple agencies within the government of the U.S. The primary study methods were photo-identification and biopsy sampling. Passive acoustics were used to aid in finding aggregations of whales. In addition, biological and oceanographic data were collected to better characterize the whale's environment, and survey data were collected for all other cetacean and pinniped species observed. Biopsy samples were also taken from other cetacean species, primarily in areas where they have been poorly sampled in the past. The Hawaiian Island Humpback Whale Sanctuary (HIHWS) collaborated on this cruise by sending two skilled photographers on each leg of survey effort. The U.S. Navy collaborated on this cruise by funding the acoustic and oceanographic sampling.

STUDY AREA:
The waters of Western Canada, Gulf of Alaska, Aleutian Islands, and Bering Sea were the principal study area. Completed tracklines covered are shown in Figure 1.

1.0 PROCEDURES FOR DAYLIGHT OPERATIONS

1.1 Cetacean Survey - Line-transect survey methods were used to collect abundance data. Search effort started on the trackline at the beginning of each day. The *McArthur II* traveled at 10 knots (through the water) along the designated trackline. If the ship's speed through the water deviated from this by more than one knot while on search effort, the bridge personnel notified the mammal team on watch or the Cruise Leader. A daily watch for cetaceans was maintained by at least three marine mammal observers on the flying bridge during daylight hours (approximately 0600 to 2000). Each observer worked in 2-hour rotations, manning each of the following three stations on the flying bridge for 40 minutes: a port side 25x150 binocular station, a centerline data recorder position and a starboard 25x150 binocular station. The rest period between watches for each observer varied with the number of available observers but was typically 2 hr 40 min and was never less than 2 hr. Daylight hours began before 0600 and ended well after 2000 during the first two legs of the cruise; surveys were conducted from sunrise to sunset.

1.1.1 Survey Design - The survey tracklines were designed to cover the expected offshore distribution of humpback whales based on recent sightings and on historical locations where humpback whales were taken by whalers. We avoided nearshore and inland waters that were sampled in summer of 2004 by other SPLASH collaborators (including inland waters of British Columbia, Southeast Alaska, Prince William Sound, and nearshore waters around Kodiak Island and Unimak Pass). When available, real-time information on the location of humpback whale aggregations was used to modify planned transect lines. Some of the planned transect lines were abandoned or were re-designed because observed humpback whale densities were lower than expected in far offshore waters. Because transect lines were designed to find high densities of humpback whales and were not random with respect to humpback whale density, line-transect data collected on this survey should not be used to estimate the line-transect density of humpback whales. Appropriate caution should be applied before using these line-transect data in estimating the density of any species to ensure that transect lines are approximately random with respect to the distribution of that species (or that appropriate geo-spatial analyses are used to allow for non-random search effort).

1.1.2 Logging of Data - A log of observation conditions, watch effort, sightings (Figure 2, Table 1), and other required information were entered into a computer, hooked up to the ship's Global Positioning System (GPS; course, speed and position information) and Scientific Computing System (SCS; weather and heading information).

1.1.3 Breaking Trackline - On sighting cetaceans or other feature of biological interest, the Cruise Leader or marine mammal observer team on watch requested that the vessel be maneuvered to approach the school or feature for investigation. When the ship approached a group of cetaceans, the observers made independent estimates of school size. Biopsy and photographic operations commenced from the bow, based on directions from the Cruise Leader or Senior Marine Mammal Observers. Considerable time was spent obtaining photographs and biopsy samples on this cruise as compared with previous SWFSC marine mammal survey. The Cruise Leader frequently requested the deployment of a small boat for biopsy, photographic or other operations (see 1.2). Occasionally, it was necessary to divert the ship's course from the established trackline during regular effort due to glare or adverse sea conditions. Under these circumstances, the ship was diverted up to 30 degrees from the established course. This

deviation was continued until the ship was 10 nm from the trackline, at which point, the ship turned back toward the trackline.

1.1.4 Reduced Search Distance - During the SPLASH cruise, there were frequent periods when fog reduced the search distance to less than one mile. During those periods, observers typically were required to vacate the flying bridge to avoid being exposed to the fog horn. Effort was maintained during these periods by an observer watch on the bridge deck. Effort was sometimes reduced to one or two observers, depending visible search area and the number of people required to adequately view this area. To maintain comparability with definitions of search effort used during previous SWFSC surveys, users of these data may want to limit analyses to periods when three people are on watch and when visibility is one mile or greater.

1.1.5 Resuming Effort - When the observers completed scientific operations for the sighting, the ship resumed the same course and speed as prior to the sighting. The Cruise Leader or Senior Marine Mammal Observers infrequently requested that, rather than proceed directly toward the next waypoint, the ship take a heading of 20 degrees back toward the trackline.

1.2 Small Boat Work - A small boat was frequently required for biopsy sampling or photography. Deployment was requested by the Cruise Leader on an opportunistic basis, including multiple times in a single day, providing the Commanding Officer concurred that operating conditions were safe. Unless the Commanding Officer allowed otherwise, the small boat remained within sight and radio contact at all times while deployed. An average of approximately 6-12 hours of small boat work occurred per day. To accommodate the high level of small boat usage, the SWFSC provided a skilled coxswain who served as the primary small boat operator on Legs 1-3. The scientific complement on most small boat launches included two photographers and one biopsy specialist. Occasionally, when conditions permitted, a second small boat was launched with one photographer and one biopsy specialist.

1.3 Biopsy Sampling - Biopsy samples for genetic analyses of marine mammals were collected frequently on this survey (Table 2). Necessary permits were present on the vessel. The animals sampled were approached by the research vessel during normal survey operations, approached the vessel on their own, or were approached by a small boat. Samples were collected using a dart fired from a crossbow or rifle when animals were within 10 to 30 m of the bow of the vessels. With the exception of the small boat and safety apparel, all necessary gear was furnished and deployed by the scientific party.

1.4 Photography - Photographs of marine mammals were taken frequently on this survey; fluke photographs of humpback whales were the primary mission for this project (Table 3). Necessary permits were present on the vessel. The animals photographed were approached by the research vessel during normal survey operations, approached the vessel on their own or approached by a small boat. With the exception of the small boat and safety apparel, all necessary gear was furnished by the scientific party.

1.5 Salvage of Marine Mammals - Permits to salvage and import marine mammal parts were present on the vessel, however, no marine mammals were salvaged during this cruise. A biopsy sample was taken from one dead whale (probably Cuvier's beaked whale) found on Leg 1.

1.6 Acoustics - A passive acoustics program was undertaken during the SPLASH survey with the intention of assisting in the detection of humpback whales, especially during inclement weather, and for opportunistic recordings of vocalizations of other cetacean species. Two procedures were used to gather these data: 1) continuous monitoring and recording from a towed hydrophone array, and 2) opportunistic deployment of sonobuoys for recording baleen whales. Unfortunately, very few humpback whale sounds

were heard and acoustics did not contribute significantly to finding this species. However, acoustics were effectively used to find right whales and sperm whales before they were seen by the visual observers and to document the presence of blue whales where none were seen. No backscatter or ADCP data were collected from the ship during this cruise.

1.6.1 Towed Array - Weather permitting, a four-element hydrophone array was deployed at daybreak and retrieved at sunset. This array was built in-house, and the hydrophones have internal pre-amplification and sensitivity from 500 Hz to 25 kHz (±10dB). It was towed 500 m behind the ship at a depth of 13 m.

Signals received from the array were amplified and monitored by one of two acoustic technicians, rotating three-hour shifts during daylight hours. Clear cetacean sounds were recorded on a Tascam DA-38 multi-channel recorder and occasionally high frequency vocalizations were recorded directly to the computer hard disk. A record was kept of acoustic effort (Table 4a), comments and five-minute acoustic updates using the program WHALTRAK. Real-time visual displays of sounds were monitored using ISHMAEL software, which also allows for localization of vocalizing animals via beamforming and phone-pair (cross-correlation) algorithms. These angles could then be plotted on the WHALTRAK display and saved to file.

Information regarding sperm whale detections was not shared between visual and acoustic teams until the animals had clearly passed abeam of the vessel; therefore, the visual and acoustic detections of this species are considered independent. Visual observers frequently relayed information about other cetacean sightings to the acoustic team to aid them in their documentation of recordings.

1.6.2 Sonobuoys - Navy surplus sonobuoys were deployed from the ship to record cetacean sounds not obtained by the hydrophone array (Table 4b). The focus of these efforts was to obtain recordings of blue whales, *Balaenoptera musculus*, right whales, *Eubalaena japonica*, and killer whales, *Orcinus orca*. Sonobuoys (type 53 or type 57) were typically deployed within one-half nautical mile of sighted animals. Sonobuoys were deployed opportunistically to monitor for right whale or blue whale vocalizations in appropriate habitat. Sonobuoy signals were recorded on a DAT recorder and monitored using a scrolling spectrographic display.

1.7 Oceanography - Oceanographic sampling was done by the Chief Survey Technician, and other designated scientists while underway during daylight hours. Thermosalinograph (surface temperature and salinity) data were collected continuously throughout the cruise.

2.0 PROCEDURES FOR NIGHT OPERATIONS

2.1 Marine Operations Log - A chronological record of oceanographic stations was kept by the ship by way of the electronic Marine Operations Log (e-MOA) with dates and times in GMT. The ship provided a copy of the e-MOA data to the SWFSC oceanographer at the completion of the cruise. Setup (including termination), maintenance and operation of the SeaBird CTD (conductivity- temperature-depth) system, including collection of oceanographic data and data processing, were conducted by the ship's Electronic and Survey Technicians. The crew of the vessel operated all deck equipment including the A-frame during CTD deployment and recovery, and was responsible for the condition of the conducting cable of the winch.

2.2 CTD Operations - When weather permitted, one CTD station was occupied each night (Table 5) when marine mammal efforts were completed. CTD data were collected using a SeaBird 9/11+CTD. All casts were to 1000 m, with the descent rate at 30 m/min for the first 100 m of the cast, then 60m/min

after that, including the upcast between bottles. Two bottles were tripped, one at 500 m and the other at 1000 m, for salinity analysis to track the conductivity sensor. The cast was conducted daily after marine mammal efforts were completed.

2.3 Transit - When scientific operations were complete for the night, the ship resumed course along the trackline to reach the start point for the next day's operations. Less nighttime transit occurred as compared to previous ETP marine mammal surveys.

3.0 SCIENTIFIC PERSONNEL

3.1 Chief Scientist - The Chief Scientist was Dr. Jay Barlow, SWFSC.

3.2 Participating Scientists -

Leg 1:

Name	Position
Jay Barlow	Cruise Leader
Cornelia Oedekoven	Identification Expert
Juan Carlos Salinas	Biopsy Project Leader
Holly Fearnbach	Photo-ID Coordinator
Michael Richlen	Mammal Observer
Richard Rowlett	Mammal Observer
Siri Hakala	HWNMS Scientist
Shannon Rankin	Acoustics Leader
Liz Zele	Acoustics Assistant
Julie Oswald	Acoustics Assistant
Todd Chandler	Coxswain - Cascadia
Allan D. Ligon	HWNMS Scientist
Robert Holland	Visiting Scientist
Lilian Carswell	Visiting Scientist
Katie Roberts	Teacher-at-sea

Leg 2:

Name	Position
Jay Barlow	Cruise Leader
Cornelia Oedekoven	Identification Expert
Juan Carlos Salinas	Biopsy Project Leader
Holly Fearnbach	Photo-ID Coordinator
Michael Richlen	Mammal Observer
Beth Goodwin	Mammal Observer
Siri Hakala	HWNMS Scientist
Shannon Rankin	Acoustics Leader
Liz Zele	Acoustics Assistant
Kate Stafford	Acoustics Assistant
Todd Chandler	Coxswain - Cascadia
Allan D. Ligon	HWNMS Scientist
Jessica Redfern	Visiting Scientist
Barb Taylor	Visiting Scientist
Linda Hoffman	Teacher-at-sea

Leg 3:

Name	Position
Lisa Ballance	Cruise Leader
Cornelia Oedekoven	Identification Expert
Juan Carlos Salinas	Biopsy Project Leader
Holly Fearnbach	Photo-ID Coordinator
Michael Richlen	Mammal Observer
Beth Goodwin	Mammal Observer
Mark Deakos	HWNMS Scientist
Richard Rowlett	Mammal Observer
Shannon Rankin	Acoustics Leader
Liz Zele	Acoustics Assistant
Lisa Munger	Acoustics Assistant
Todd Chandler	Coxswain - Cascadia
Amanda Cummins	HWNMS Scientist
John Brandon	Visiting Scientist
Bob Pitman	Visiting Scientist
Leigh Torres	Visiting Scientist

Leg 4:

Name	Position
Karin Forney	Cruise Leader
Cornelia Oedekoven	Identification Expert
Juan Carlos Salinas	Biopsy Project Leader
Holly Fearnbach	Photo-ID Coordinator
Michael Richlen	Mammal Observer
Beth Goodwin	Mammal Observer
Mark Deakos	HWNMS Scientist
Richard Rowlett	Mammal Observer
James Cotton	Mammal Observer
Shannon Rankin	Acoustics Leader
Liz Zele	Acoustics Assistant
Julie Oswald	Acoustics Assistant
Amanda Cummins	HWNMS Scientist
Megan Ferguson	Visiting Scientist

4.0 RESULTS

The following summarize the area surveyed and data collected:

Figure 1: Tracklines surveyed

Figure 2: Location of all humpback whale sightings. Note sightings are plotted over the tracklines.

Table 1. Summary of the number of cetacean sightings during each Leg of the SPLASH 2004 survey.

Table 2. Number of cetacean biopsy samples collected during SPLASH 2004.

Table 3. Preliminary estimates of the number of cetacean and pinniped photographs obtained during SPLASH 2004 (digital and some 35 mm).

Table 4a. Acoustic recordings of cetaceans obtained using the towed hydrophone array for each leg of the SPLASH cruise (all non-sighted unidentified dolphins are probable killer whales).

Table 4b. Number of sonobuoys deployed to obtain acoustic recordings of cetaceans for each leg of the SPLASH cruise. Opportunistic recordings were made at various times during the day and night to listen for blue or right whales. Not all recordings contain vocalizations from the target species.

Table 5. Summary of environmental data collected during SPLASH 2004.

5.0 DISPOSITION OF DATA

All data are currently being analyzed. The final data reports will be completed by August 2005.

Marine mammal and passive acoustic data were delivered to the Chief Scientist, Dr. Jay Barlow, SWFSC, for analysis and distribution.

Biopsy samples were delivered to Dr. Barbara Taylor, SWFSC, for analysis and distribution.

Oceanographic data were delivered to Dr. Paul Fiedler, SWFSC, for analysis and distribution.

Prepared by: _____ Date: 28 Mar' 05
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Chief Scientist, SPLASH 2004

Prepared by: _____ Date: 28 Mar 05
Annette Henry
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Dr. Stephen B. Reilly
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Approved by: _____ Date: 4/1/5
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Director, Southwest Fisheries Science Center

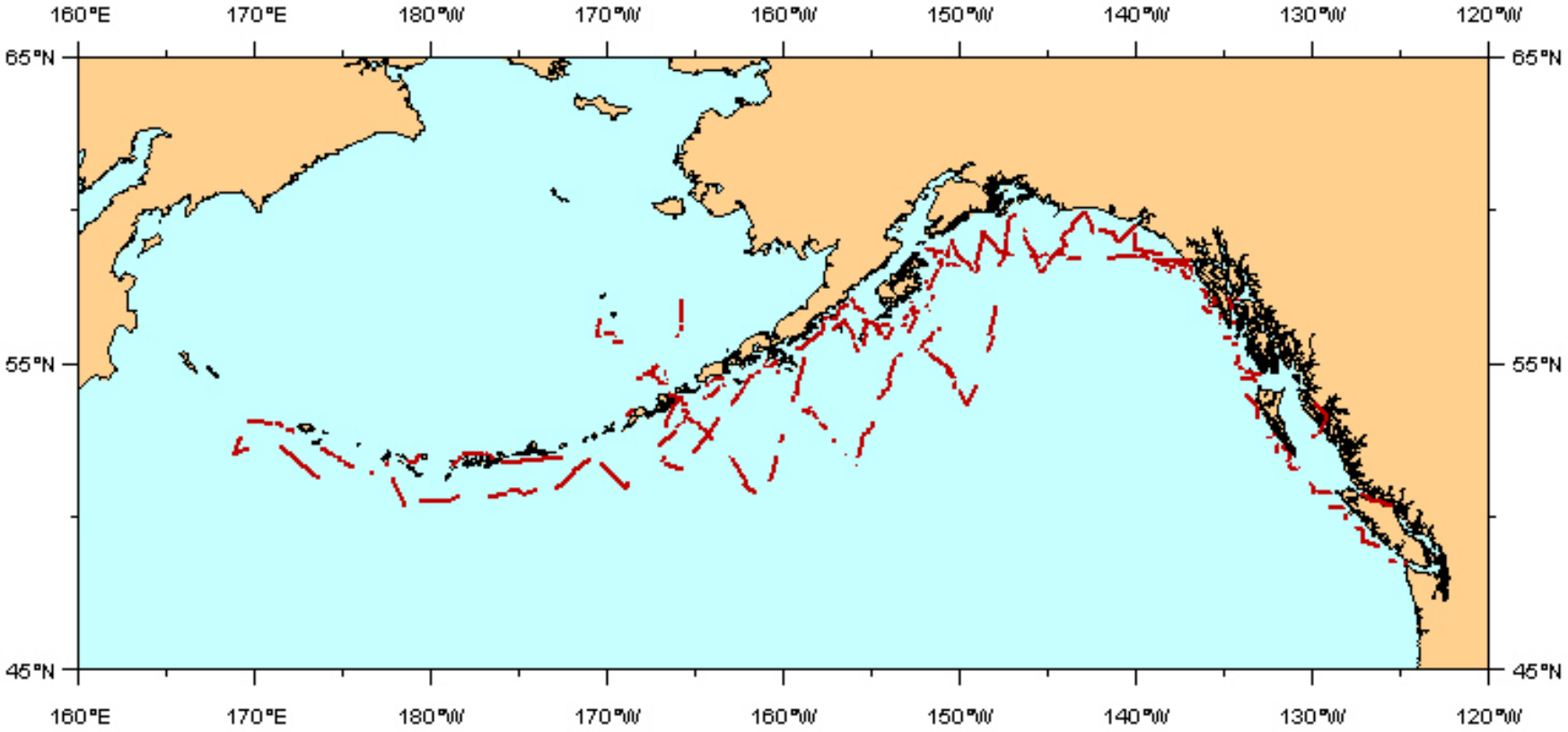

Figure 1. Tracklines (red) surveyed during daylight hours aboard the NOAA Ship *McArthur II* during SPLASH 2004.

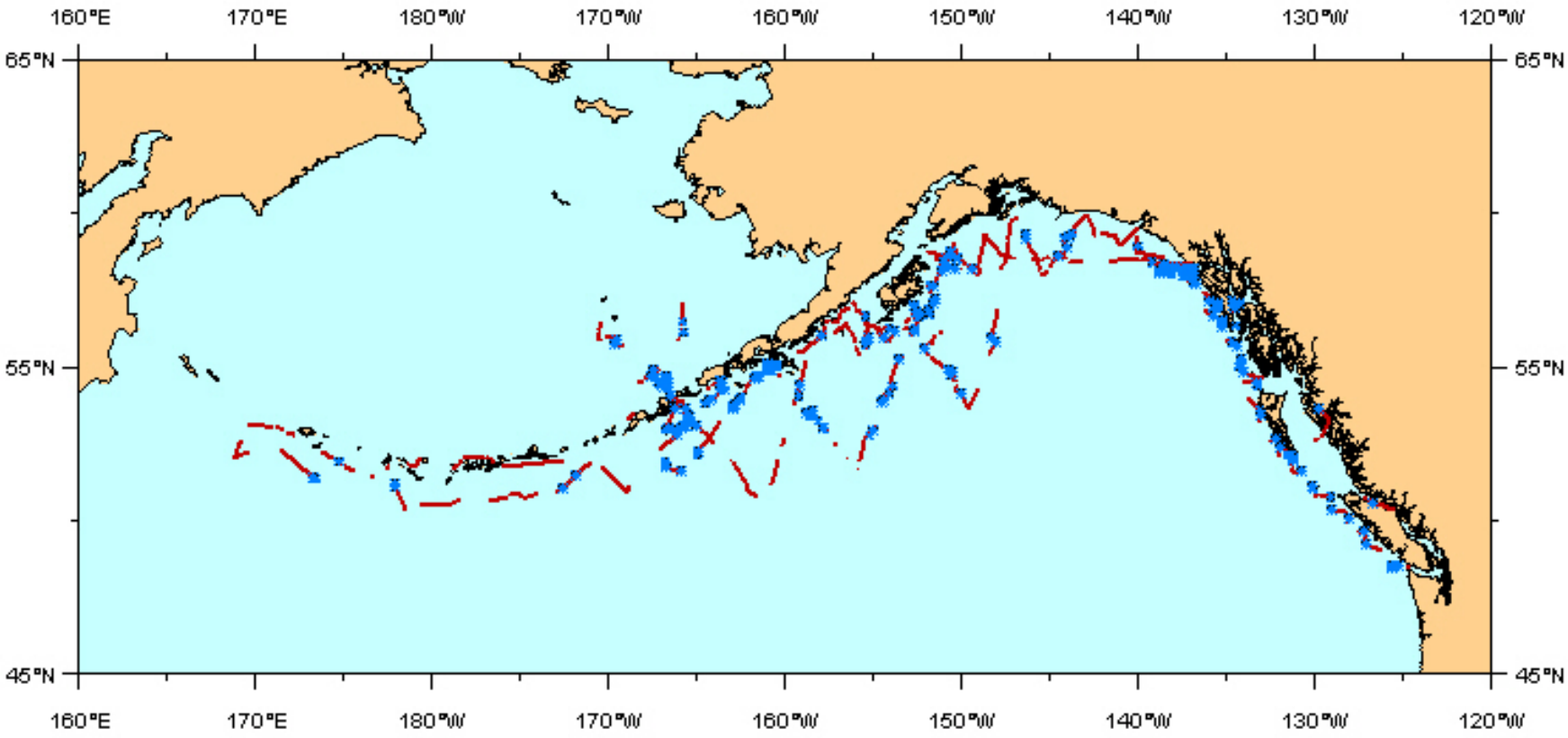

Figure 2. Location of all humpback whale sightings. Note sightings (in blue) are plotted over the tracklines (red).

Table 1. Summary of the number of cetacean sightings during each Leg of the SPLASH 2004 survey.

Sighting category	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Total**
Lagenorhynchus obliquidens	6	0	0	1	7
Lissodelphis borealis	2	0	0	0	2
Orcinus orca	9	27	18	7	61
Phocoenoides dalli	1	0	0	0	1
Physeter macrocephalus	35	24	7	3	69
Ziphiid whale	0	1	0	1	2
Mesoplodon sp.	4	1	0	1	6
Ziphius cavirostris	4	1	0	0	5
Berardius bairdii	6	0	0	1	7
Eubalaena japonica	0	0	8	0	8
Balaenoptera sp.	12	2	9	14	37
Balaenoptera acutorostrata	8	6	2	2	18
Balaenoptera physalus	94	11	79	67	251
Balaenoptera musculus	3	2	0	0	5
Megaptera novaeangliae	110	79	61	65	315
Unidentified small whale	1	6	0	0	7
Unidentified large whale	11	9	36	12	68
Mesoplodon stejnegeri	1	2	0	0	3
Unidentified cetacean	1	4	0	2	7
Unidentified whale	1	1	0	2	4
Unidentified medium delphinid	0	1	0	0	1
Total	309	177	220	178	884

Table 2. Number of cetacean biopsy samples collected during SPLASH 2004.

Species	**Number of biopsy samples**
Orcinus orca	42
Phocoenoides dalli	2
Physeter macrocephalus	8
*Ziphius cavirostris**	1
Berardius bairdii	6
Eubalaena japonica	22
Balaenoptera physalus	64
Balaenoptera musculus	4
Megaptera novaeangliae	507
Total	656

* dead when sampled

Table 3. Preliminary estimates of the number of cetacean and pinniped photographs obtained during SPLASH 2004 (digital and some 35 mm).

Species	**Category**	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Total**
Megaptera novaeangliae	Catalogue-quality flukes	304	186	186	241	917
Balaenoptera physalus	dorsal	42	5	45	16	108
Eubalaena japonica	head	0	0	23	0	23
Physeter macrocephalus	fluke	9	4	0	3	16
Balaenoptera musculus	dorsal	3	2	0	0	5
Balaenoptera acutorostrata		0	1	0	0	1
Orcinus orca	dorsal	54	83	81	208	426
Berardius bairdii		15	0	0	6	21
Lissodelphis borealis	groups photographed	1	0	0	0	1
Lagenorhynchus obliquidens	groups photographed	3	0	0	0	3
Ziphius cavirostris	dead when photographed	1	0	0	0	1
Eumetopias jubatus		1	0	0	0	1
Total		433	281	335	474	1,523

Table 4a. Acoustic recordings of cetaceans obtained using the towed hydrophone array for each leg of the SPLASH cruise (all non-sighted unidentified dolphins are probable killer whales).

Species	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Total**
Physeter macrocephalus (non-sighted)	27	69	23	9	128
Physeter macrocephalus (sighted)	18	13	5	1	37
Orcinus orca	2	10	7	0	19
Unidentified Dolphins (non-sighted)	3	6	4	1	14
Berardius bairdii	2	0	0	0	2
Lagenorhynchus obliquidens	1	0	0	0	1
L. obliquidens and *Lissodelphis borealis*	1	0	0	0	1
Total	**54**	**98**	**39**	**11**	**202**

Table 4b. Number of sonobuoy recording events for cetaceans during each leg of the SPLASH cruise. Opportunistic recordings were made at various times during the day and night to listen for blue or right whales. Not all recordings contain vocalizations from the target species.

Species	**Leg 1**	**Leg**	**Leg 3**	**Leg 4**	**Total**
Opportunistic sonobuoys	0	9	5	1	15
Eubalaena japonica	0	0	10	0	10
Orcinus orca	2	0	3	0	5
Balaenoptera musculus	3	2	0	0	5
Balaenoptera physalus	1	0	0	0	1
Balaenoptera acutorostrata	0	0	1	0	1

Table 5. Summary of environmental data collected during SPLASH 2004.

Description	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Total**
CTD casts	24	24	19	24	91
Salinity samples	48	48	38	48	182